TECHNICAL MANUAL

OPERATION

PROGRAM 437 WEAPON SYSTEM

This publication is supplemented by T.O. 21M-437-1-1-1A which is classified to permit this basic publication to be unclassified.

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1-1. SCOPE OF MANUAL.

1-2. This manual provides a general description of the Program 437 Weapon System, Refurbishment through Ready Condition, Weapon System Employment, Emergency Procedures, Malfunction Procedures, Operating Limitations and Restrictions, and combat crew procedures. It provides a general description of the Program 437 Weapon System for training purposes at Vandenberg Air Force Base (VAFB). A thorough knowledge of the information contained in T.O. 21M-437-2-13-1, Maintenance Instructions, Monitoring and Countdown Circuits is necessary for a complete understanding of the operational control, modes of operation exercise countdowns, and launch countdown (T.O. 21M-437-2-13-2 is to be used at VAFB only). Those paragraphs that refer to VAFB only are so indicated.

1-3. The Glossary contains a complete list of nonstandard abbreviations used in Program 437.

1-4. The following Time Compliance Technical Orders have been incorporated into this manual: T.O. 21M-437-518, dated 18 August 1967, and T.O.'s 21M-437-530 and 31S7-2GKR5-501, dated 8 April 1970.

1-5. Safety precautions for the Program 437 weapon system are contained in various technical orders applicable to Program 437. A list of the technical orders that contain these safety precautions is located in the foreward of this manual.

1-6. PROGRAM 437 MISSION.

1-7. The program 437 mission is to destroy designated foreign-launched satellites in consonance with operational control procedures directed by the Commander in Chief, Continental Air Defense Command (CINCONAD).

1-8. PRIMARY MISSION OBJECTIVE. The primary mission objective is to achieve optimum operational effectiveness to negate, by means of a non-orbital payload, an earth satellite within the area of influence of the system. This is accomplished by launching the vehicle within a bounded time window, guiding the vehicle through MECO, and delivering the payload to a preselected time-space intercept point (IP). The bounded time window may be defined as the maximum variation in lift-off time that will allow successful completion of the mission.

1-9. CAPABILITY, RELIABILITY, AND EFFECTIVENESS. Mission success depends upon the capability of the launch vehicle to deliver the payload to the selected time-space point with a high degree of reliability, followed by an effective response of the payload to a ground based command. In order to achieve this success, it is necessary that all subsystems, ground as well as flight, respond with accuracy.

1-10. WEAPONS SYSTEM DESCRIPTION.

1-11. JOHNSTON ISLAND (JI).

1-12. The program 437 weapon system located at Johnston Island consists of two launch vehicles (LV-2D); associated aerospace ground equipment (AGE); associated mission and launch control facilities, which provide a launch countdown system including a targeting/guidance computing system (TGCS), mission safety system, and payload command system on Johnston Island (JI) (Figure 1-1). Missiles with supporting AGE are in an operational ready status on JI and backup missiles are

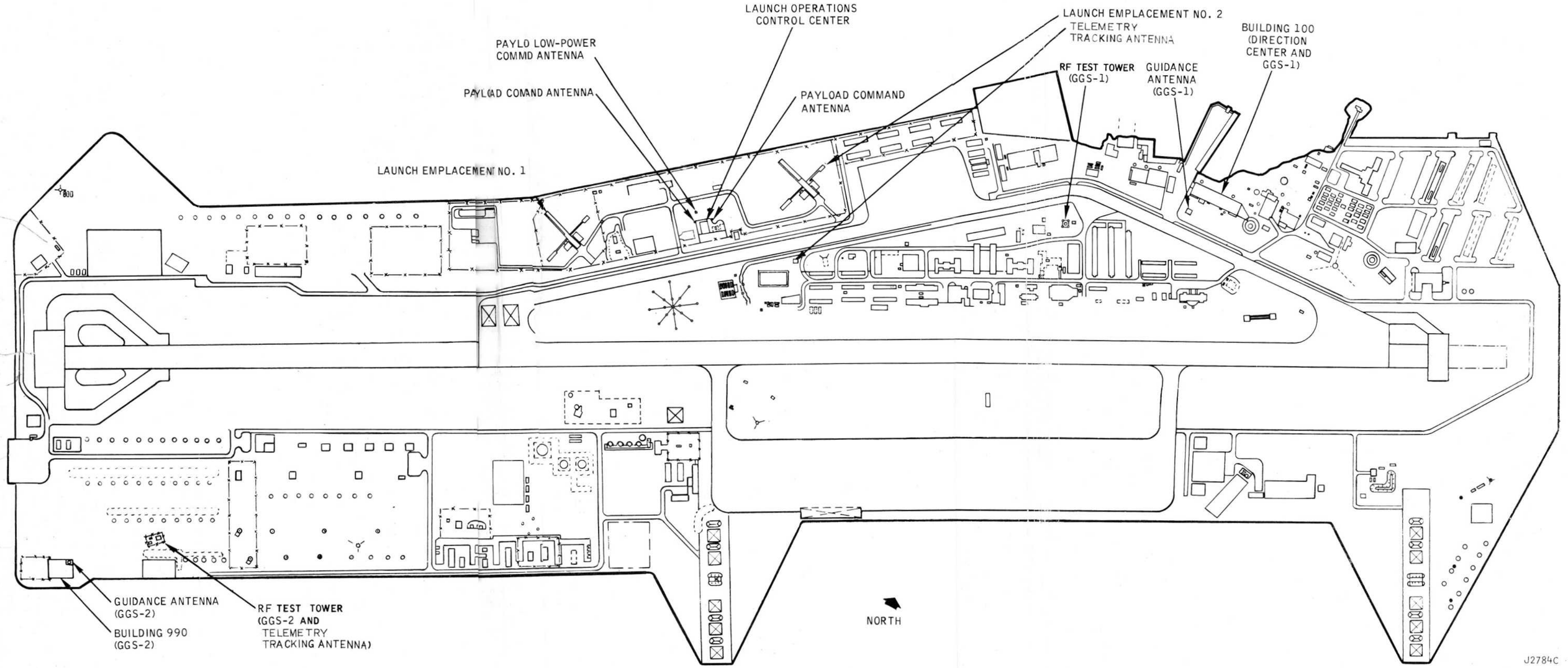


Figure 1-1. Johnston Island -- General Arrangement

at Vandenberg Air Force Base (VAFB). At VAFB, missiles are stored as operational ready backup and for training. A dual missile countdown concept is employed to increase system reliability.

1-13. The launch countdown is designed to check out, countdown, and launch a vehicle with payload assembly at a precise preselected time. The launch countdown system also provides for controlled vehicle flight to a predetermined intercept point (IP) for destruction of the target. The launch countdown of the vehicle is controlled from the control center (CC) which is supervised and controlled by the direction center (DC). Ground Guidance Station 1 (GGS-1) or Ground Guidance Station 2 (GGS-2), whichever is prime, provides targeting and mission safety data to the mission safety officer (MSO) at the DC. See Figure 1-2 for the launch countdown system facilities. (VAFB, Figure 1-4).

1-14. VANDENBERG AFB (VAFB).

1-15. (VAFB) One launch vehicle, associated AGE, and associated launch control facilities which provide a launch countdown system are provided at VAFB. No launches from VAFB are planned; therefore, no CINCONAD controlled targeting system is provided and mission safety functions are limited to ground operations. Certain ground guidance and destruct system functions are simulated by the console simulator. Only a single launch countdown is conducted. However, the Ground Guidance Station (GGS-3) is capable of sending RF signals to the missile for simulated in-flight steering. Also, a simulated condition ONE and TWO changeover can be performed utilizing an alternate communications network. (For missile changeovers refer to paragraph 5-7.)

1-16. (VAFB) The control center, telemetry and timing equipment is functionally identical to that employed at the operational site (CC-2). A ground guidance/computer station (GGS-3) and a payload vehicle trainer are provided. Payload vehicle training is not limited by any equipment constraints imposed.

1-17. AEROSPACE GROUND EQUIPMENT (AGE).

1-18. AGE consists of components which affect the achievement of an accurate, reliable and timely launch. This equipment is divided into five areas: Control Center (CC), Launch Emplacement launching equipment, Checkout equipment, Power generation equipment, and Direction Center (DC).

1-19. The CC equipment consists of consoles, racks, and junction boxes for distribution of power and signal information, as well as control timing units, countdown clocks and time-of-day clocks. The booster telemetry and camera control consoles are also located in the CC.

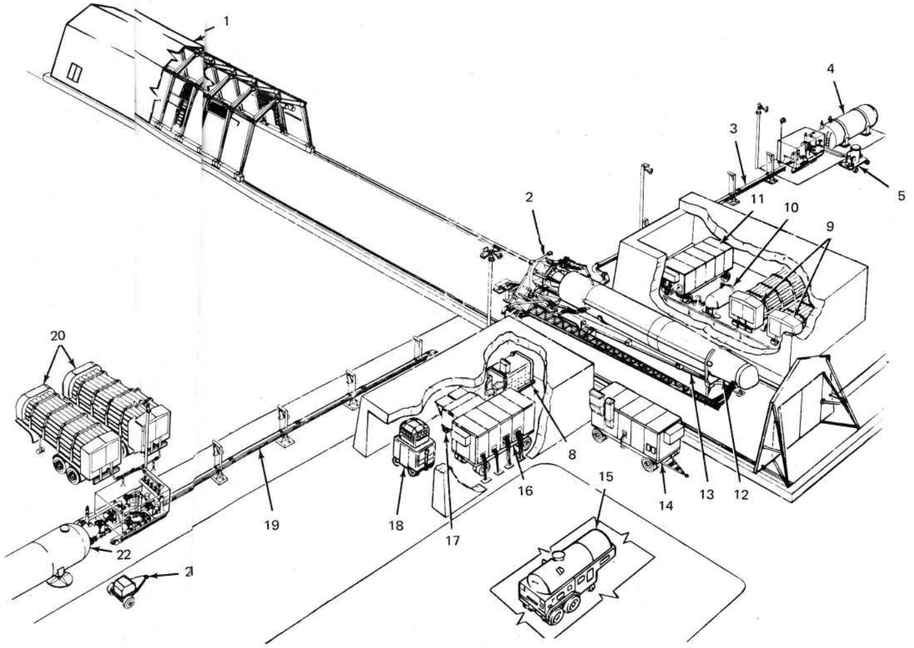
1-20. Launch emplacement launching equipment consists of missile erector transporters, launch mounts, equipment trailers, fuel and oxygen tanks, propellant transfer equipment and cabling networks which electrically connect the launch emplacement to the blockhouse.

1-21. Checkout equipment consists of checkout trailers, supplementary checkout trailers, area cables, simulators and test sets.

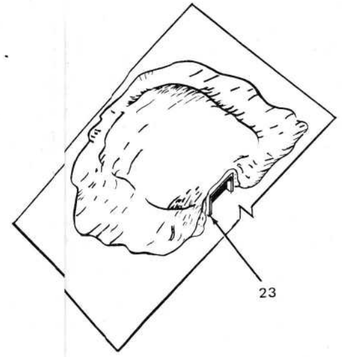
1-22. (VAFB) The power generation system consists of four trailer-mounted diesel engine generators (gen van) and a power distribution trailer (PDT) for the launch emplacement. Each generator van is equipped with a four-cycle, V-12 cylinder turbo-charged engine which develops 575 hp at 1800 rpm and a three-phase, 60-cycle 480V AC generator which develops 250 kw with a 96% reliability of less than 0.1% drift.

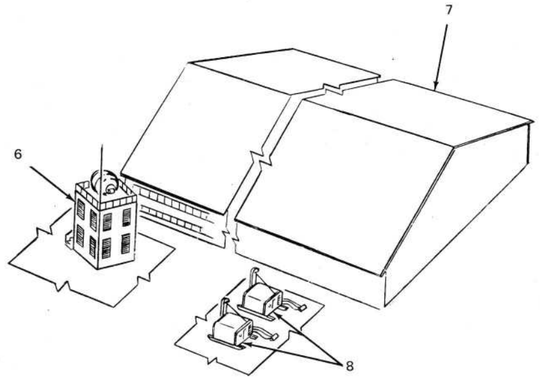
1-23. The Direction Center in Building 100 is the focal point for mission command and control. The Direction Center equipment consists of consoles (for a commander, an operations officer, a maintenance officer, and a mission safety officer) and communications, plotting, and display facilities. Launch and destruct enabling and guidance station select are controlled

1. PANELIZED PREFABRICATED BUILDING SHU-19/E
2. LAUNCH VEHICLE ERECTING-LAUNCHING MOUNT MTU-35/E AND MTU-36/E
3. FUEL PIPELINE OUTFIT GSU-197/E AND GSU-198/E
4. FUEL STORAGE TANK TMU-4/E
5. TRAILER-MOUNTED FUEL FILTER UNIT GSU-7/M
6. GUIDANCE ANTENNA (GGS-1)
7. BUILDING 100
8. SKID-MOUNTED POWER SWITCHBOARD JEU-1/E
9. COMPRESSED GAS CYLINDER SEMITRAILER AF/M32A-17 (FUEL SIDE)
10. HIGH-PRESSURE GAS STORAGE TANK TMU-33/E
11. TRAILER-MOUNTED HYDRO-PNEUMATIC SYSTEMS CONTROLLER A/M46A-2A
12. LAUNCH VEHICLE, PART NO. 5727000-503 (MODIFIED BY 1A72845-1)
13. BALLISTIC MISSILE ERECTING-TRANSPORTING BOOM GSU-193/E
14. TRAILER-MOUNTED LAUNCH VEHICLE SYSTEM CHECKOUT STATION A/M24A-6
15. SEMITRAILER-MOUNTED OXYGEN-NITROGEN RECHARGER A/M 32R-6
16. TRAILER-MOUNTED MISSILE LAUNCHING COUNTDOWN GROUP A/M24A-3
17. HYDRAULIC PUMPING UNIT PMU-30A/E
18. TRAILER-MOUNTED AIR CONDITIONER A/M32C-11
19. LIQUID OXYGEN PIPELINE OUTFIT GSU-199/E
20. COMPRESSED GAS CYLINDER SEMITRAILER AF/M32A-17 (LOX SIDE)
21. TRAILER-MOUNTED VACUUM PUMP PMU-1A/M
22. LIQUID OXYGEN STORAGE TANK TMU-3/E
23. CONTROL CENTER
24. BUILDING 990 (GGS-2)
25. GUIDANCE ANTENNA (GGS-2)



LAUNCH EMPLACEMENT (TYPICAL 2 PLACES)





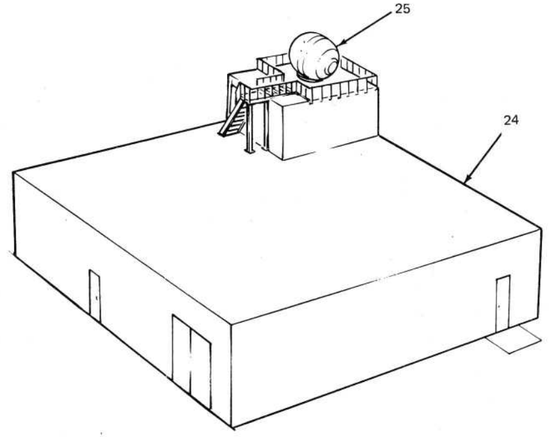


Figure 1-2. Program 437 Launch Countdown System Facilities - J.I.

from the commander console. The launch timing system is controlled from the operations officer console. The destruct capability for the launch vehicle and payload assembly is controlled from the mission safety officer console.

1-24. (VAFB) VAFB training facilities and AGE duplicate the operational site as closely as possible. Difference in the physical aspects of the operational and training sites dictate some differences in equipment location and requirements. In most cases, differences between equipment which performs identical functions are slight. Whenever equipment is modified or redesigned to the extent that interchangeability with operational equipment is lost, the equipment model number is changed. Operational equipment which has been modified for use at VAFB is identified in this manual with the VAFB configuration, and its function correlated with that of the operational equipment.

1-25. (VAFB) The control center (CC) at VAFB duplicates the functions provided by the CC and direction center (DC) at the operational site; however, the equipment layout differs due to the shapes and dimensions of the buildings. Unique facility items such as the firex water deluge system, audio communications, and traffic control dictate differences in the control consoles. Location of the CC in relation to the launch emplacement requires unique cable networks for VAFB. Absence of a DC at VAFB necessitates the addition of a Control Center Console Simulator AN/GSA-71 to simulate the DC functions in order to complete the training capability at the VAFB site. Other equipment has been relocated for physical convenience with no change in function.

1-26. LAUNCH VEHICLE.

1-27. The launch vehicle (LV-2D) is the modified SM75 (Thor) single stage missile equipped with radio guidance, a telemetry system, and a mission safety system. Each vehicle consists of the following:

a. A cylindrical 2-tank airframe structure.

b. A main engine (ME) and two vernier engines (VE) using liquid oxygen (LOX) and RP-1 as propellants. The main engine develops 150,000 pounds (±3 per cent) of thrust and each vernier engine provides an additional 1000 pounds (±3 per cent) of thrust. Refer to classified supplement for missile flight range.

c. A hydraulic system for gimballing the engines. Gimballing of the engines provides roll, pitch, and yaw control during powered flight. The main engine gimbals to provide pitch and yaw corrections in flight and the two vernier engines provide roll corrections as well as augmentation of the main engine in yaw and pitch. After main engine cutoff (MECO), the vernier engines provide stabilization until vernier engine cutoff (VECO).

d. A pneumatic system with three missile bottles for supplying gaseous nitrogen (GN_2) to the vehicle fuel tank, engine start tank, vernier engine propellant system, and other pneumatic systems.

e. An electrical system with four 28-vdc batteries for furnishing power to the control electronics assembly (CEA), motor generator, relays, squibs, guidance unit, telemetry/instrumentation system, and command destruct system receivers.

f. A range safety vehicle command destruct system for terminating thrust and destroying the vehicle on command.

g. An airborne telemetry system for obtaining vehicle performance and environmental data from selected sources within the vehicle.

1-28. VEHICLE GUIDANCE AND CONTROL.

1-29. The Control Electronics Assembly (CEA), located in the guidance section of the booster, consists of electromechanized components and circuits to stabilize and control the missile. The CEA contains a programmer to control the time and sequence of predetermined commands from lift-off until payload separation. From

the ground guidance station (GGS), the missile borne guidance set (MBGE) receives RF signals containing appropriately addressed steering orders and discrete and sequence commands. The missile ventral or dorsal antennas pick up the signals and send them through a waveguide assembly to the receiver. The receiver decodes the signals and transmits the information to the CEA. These signals torque the CEA gyros which in turn gimbal the engines, cut off the engines (MECO and VECO), and separate the payload from the booster at the appropriate time. The GGS also generates a trigger signal which causes the missile borne guidance equipment (MGBE) transmitter to transmit a monopulse RF signal to the ground guidance receiver. The monopulse signal is used by the ground station to continuously determine the position and velocity of the missile.

1-30. VEHICLE COMMAND DESTRUCT SYSTEM.

1-31. The vehicle command destruct system consists of two integral sub-systems, each consisting of one command destruct receiver, two antennas, safe and arm (S&A) mechanism, and associated circuitry. The destructor, common to both subsystems, consists of primacord in the tunnels along the sides of both propellant tanks and around the base of the vehicle LOX tank. Either command destruct subsystem is capable of initiating MECO and destroying the vehicle. Each subsystem receives internal power from separate batteries. Prior to lift-off, booster destruct cannot be initiated since the detonators are mechanically held in the safe position. At missile lift-off, lanyards attached to the launcher are pulled causing rotation of the detonators from safe to the armed position.

1-32. VEHICLE TELEMETRY SYSTEM.

1-33. The vehicle telemetry system consists of FM/FM and PDM/FM/FM link which transmits from twelve minutes before missile lift-off until the loss of tracking signal to provide flight information.

1-34. GROUND GUIDANCE EQUIPMENT.

1-35. TARGETING/GUIDANCE COMPUTING SYSTEM (TGCS). The TGCS consists of GGS-1 or GGS-2, the data processing system (DPS), and two DC plotting boards. GGS-1, the DPS, and the DC plotting boards are located in Building 100. GGS-2 is located in Building 990. GGS-1 and GGS-2 are the same configuration, so only one is selected as prime for a mission for use with the DPS and DC plotting boards. The targeting computing portion of the TGCS processes messages transmitted from the Integrated Space Defense Center (ISDC) to produce data for target IP identification, to verify ISDC guidance parameters, and to display real-time mission safety data. The guidance radar portion of the system tracks the launch vehicle in flight, supplies vehicle position information to the CP-642B targeting/guidance computer (TGC), encodes steering orders and discrete commands, and transmits these orders and commands to the vehicle-borne guidance set. The TGC generates the roll and pitch commands based on predetermined nominal trajectory. After guidance initiation (T+90 seconds), the TGC receives information from the guidance radar concerning position of the vehicle, and then generates the pitch and yaw steering commands necessary to place the payload at the desired position at the time of intercept (T_I).

1-36. (VAFB) GGS-3 consists of a targeting/guidance computing system only. GGS-3 is located in Building 1850 and is similar in layout to GGS-1 and GGS-2. Variations include a switch to change plotting from PP to IIP, and four radar cabinets (3, 17, 19, & 26) located in the antenna terminal. This facility is used to train and certify guidance personnel. The guidance program for GGS-1 has been readily adapted for use at GGS-3. Periodic dry exercises and steering and command tests can be conducted with the launch vehicle.

1-37. The TGC has two basic functions: (1) processing targeting data to provide

guidance parameters for use by the guidance real-time (GRT) program, and (2) processing the GRT program. The targeting programs provide an intercept point with guidance parameters (IG) message (printout and paper tape), a printout of nominal trajectory parameters, payload agency and mission safety messages, present position (PP), flight evaluation display (FED), and instantaneous impact point (IIP) plots for nominal flight trajectory evaluation, and a magnetic tape record of radar history for nominal trajectory, which will be used in the GRT program. The GRT program contains the countdown tasks, together with equations, to guide the vehicle during flight and to command various discrete functions. The various routines of the program are run in an exact sequence. There are seven routines, with the last placing the computer in a synchronous mode, which initiates the terminal countdown phase for the guidance system. From this point, the computer functions automatically until the end of the vehicle's powered flight and payload separation. The select target routine performs the guidance logic setup, enables radar/computer interface, synchronizes the guidance program with real-time, performs two loop checks, transmits engine start signal via a hardwire, performs real-time guidance control of the vehicle via the radar data link, generates a flight evaluation printout, records data until the loss of radar signals, and provides data for the DC and GGS plotting boards.

1-38. GROUND GUIDANCE STATION (GGS) SELECTION. Selection of the prime GGS is determined by the targeting message from the ISDC. The targeting data received will mention if the data is compatible for either or both stations. The launch azimuth and range of both stations is limited to certain areas due to the physical characteristics of the command guidance radar tracking system. (Refer to classified supplement for GGS physical characterisitics.)

1-39. GROUND GUIDANCE STATION SELECTOR SWITCH. The GGS selector switch, located in the DC, activates relays in the CC to provide a means of interfacing the prime GGS (GGS-1 or GGS-2) to the launch complex. Two additional switches mounted on the wall near the DC plotting boards are used to switch control of the DC plotting boards to the selected GGS.

1-40. MISSION SAFETY SYSTEM.

1-41. The mission safety system operation is concerned with protection of life and property within areas under the influence of the vehicle and payload assembly. The mission safety system uses certain capabilities and functions of the TGCS and the payload control system. Capabilities and functions are displayed and/or controlled by the MSO's equipment consisting of two DC plotting boards, a count-up clock indicator, and a safety panel. Real-time vehicle position information is sent from the TGCS to provide coordinate data to the DC plotting boards for PP, IIP, and FED plots. The mission safety system functions within the predetermined requirements imposed by the Continental Air Defense Command (CONAD) for the designated level of mission urgency. The mission safety system responds by establishing conditions of hazardous flight which require mission safety action, detecting and recognizing a potentially hazardous flight condition, and terminating flights which are hazardous. The level of mission urgency encompasses situations varying from implied abandonment of safety restraints in cases carrying the highest national urgency for target negation to full use of standard safety practices in cases of training launches. Depending on the level of risk, predetermined probability contours afford protection to various areas designated as island hazard areas.

1-42. Vehicle PP, IIP, and FED data are displayed by the DC and GGS plotting boards. One DC plotting board and the GGS plotting boards display PP and FED data, and the other DC plotting board displays IIP data. The GGS plotting boards are operated by signals from the TGC. The DC plotting boards are operated by signals from the TGC through the integrated message switch (IMS) for GGS-2 and direct for GGS-1.

1-43. The PP data presented on the DC plotting board and the GGS plotting boards

provide an indication of the vehicle's real-time position in space referenced to the launch site. The upper portion of the plot displays downrange-crossrange (X-Y) data, while the lower portion displays downrange-altitude (X-Z) data. During TJP, altitude and downrange distances are displayed in feet for the first 90 seconds of flight and in nautical miles for the remainder of the simulated flight. During MS nominals and actual flight, the downrange-altitude plot is terminated at T+90 seconds and FED plotting is initiated.

1-44. The FED data displayed on the DC plotting board and the GGS plotting boards present a visual display of predicted guidance miss distance. The FED presents a history of predicted intercept point cross-vector miss distance as a function of time until main engine cutoff (MECO). The fixed line on the plotting board chart represents the maximum error that a normally operating guidance system can correct in the remaining time to MECO.

1-45. The IIP data presented on the DC plotting board provides the MSO with a visual display of instantaneous vehicle impact location should thrust terminate. IIP data also provide an indication of gross vehicle performance and the proximity of the vehicle impact point to land masses.

1-46. PAYLOAD EQUIPMENT.

1-47. Refer to Section I, T.O. 21M-437-1-1-1A for a description of the payload equipment.

1-48. GROUND TELEMETRY.

1-49. TELEMETRY ANTENNA SYSTEM (TAS). The telemetry antenna system consists of two major groups, the Antenna Group and the Control Group. The TAS is a radio-frequency signal receiving and tracking system capable of acquiring and tracking an airborne signal source operating in the S_C-Band (2-2 to 2-3 GHZ). The system is capable of tracking such signal sources in both azimuth and elevation simultaneously at rates of up to 15 degrees per second. Such signals may be unmodulated or any standard Inter-Range Instrumentation Group (IRIG) type of modulated signal, including AM-FM, PWM-FM, and PCM-FM. Acquisition of such signals may be manual, slaved, preprogrammed, or semi-automatic. Tracking may be fully automatic, programmed, slaved, or manual. Mounted on the antenna is a Television Camera. The camera and its corresponding monitor, mounted in the Control Group Console, provide the capability to sight remotely along the electronic axis of the antenna. The Control Group is a 4-bay rack mounting the electronics units for the Antenna/Pedestal Group, the two command mount control units, and the associated servo units. An oscilloscope for use with the timing and sequencing equipment and two communications panels are also mounted in the Control Console.

1-50. TIMING.

1-51. TIMING AND SEQUENCING SYSTEM. The timing and sequencing equipment provides accurate timing for control of payload assembly events for the booster countdown timing system, the guidance computer, and the radar events recorder. The equipment provides duplicate systems, each containing a time code generator, countdown clock, and preset timer mounted in cabinets in the payload launch operations room of the CC, and an antenna mounted outside the CC. A time code distribution unit located in a separate cabinet in the payload launch operation room receives time codes generated in the time code generator and distributes them to the booster countdown timing system, the guidance computer, and the radar events recorder. The time code generators provide a continuous visual display of day of year and time of day to the nearest second. A preset to start 10 PPS output of the time code generator is fed to the H-time countdown clock which counts in 0.1 second intervals and feeds a decimal coded output to a preset timer. When the digital output coincides with the time set into the preset timer, a relay closes to complete a controlling function in the command system.

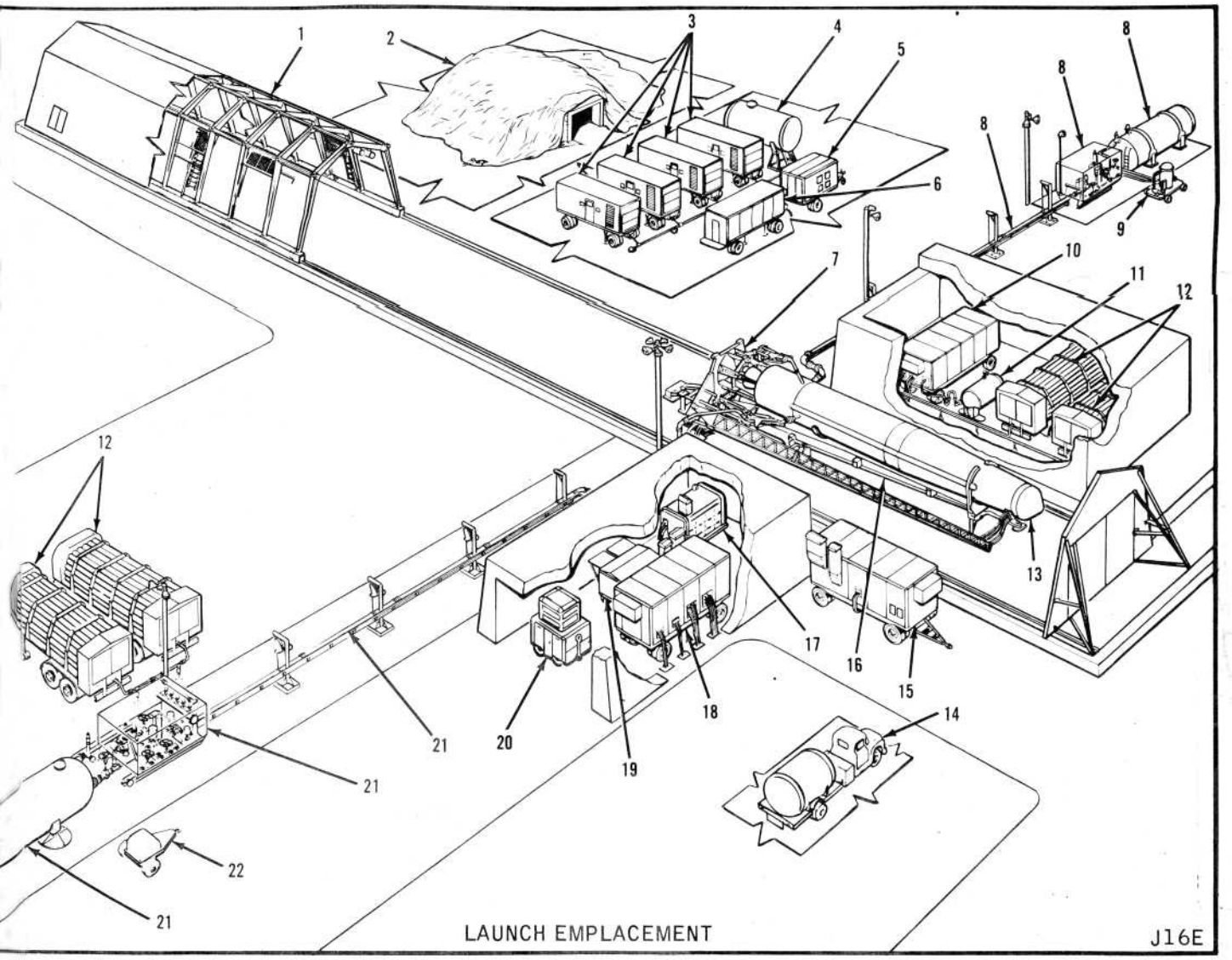
1-52. COUNTDOWN CLOCK. The countdown clock installed on the vehicle countdown console in the DC is used to generate pulses at designated times during the terminal countdown. The countdown clock transmits six pulses to each launch emplacement countdown system. These pulses are 28VDC at one second time duration. Three pulses are fixed, and three are variable (set in by the console operator). The letter T is designated as the precise liftoff time. The three fixed pulses are: LOX Transfer Resume at T-60 seconds, Phase 4 Check 2 at T-10 seconds, and Abort at T+30 seconds. The three variable pulses are: Time Select A, Time Select B, and Time Select C. Time Select C is not used in Program 437. Time Select A pulse is used to initiate Phase 4 begin. The primary vehicle begins Phase 4 at T-300 seconds (5 minutes) and the alternate vehicle begins Phase 4 at T-180 seconds (3 minutes). Time Select B pulse is used as Phase 4 Check 1 which occurs at T-3 minutes 30 seconds on the primary vehicle and T-20 seconds on the alternate vehicle. The fixed abort pulse, T+30 seconds for the primary vehicle, is locked out after engine start signal is received.

1-53. LAUNCH COUNTDOWN SYSTEM AGE.

1-54. Table 1-1 provides a summary of the launch countdown system AGE. Figures 1-3 through 1-34 locate and illustrate the consoles and panels used for control and monitor functions during launch countdown.

Table 1-1. Summary Launch Countdown System AGE

EQUIPMENT NAME	PURPOSE
Antennas (figure 1-1)	
Guidance (6 and 25, figure 1-2)	Provides one antenna for each ground guidance station (GGS-1 or GGS-2) for transmitting guidance commands to the vehicle.
Payload Command	Provides two parabolic antennas for transmitting commands to the payload assembly (only one antenna is used at a time).
Payload Low-Power Command	Provides a yagi antenna for transmitting low-power commands to command receivers during radio frequency (RF) sensitivity check.
Telemetry Tracking	Provides for vehicle tracking and data reception during T/M operations.



LAUNCH EMPLACEMENT J16E

1. Panelized Prefabricated Building SHU-19/E
2. Control Center
3. Semitrailer-Mounted Diesel Engine Generator Set A/M32A-68
4. Diesel Fuel Storage Tank TMU-5/E
5. Trailer-Mounted Electrical Dummy Load A/M24T-4
6. Trailer-Mounted Power Distribution Station A/M24A-7
7. Launch Vehicle Erecting-Launching Mount MTU-35/E and MTU-36/E
8. Fuel Storage Tank TMU-4/E, Fuel Valve End Complex and Fuel Pipeline Outfit GSU-197/E and GSU-198/E
9. Trailer-Mounted Fuel Filter Unit GSU-7/M
10. Trailer-Mounted Hydro-Pneumatic Systems Controller A/M-46A-2A
11. High-Pressure Gas Storage Tank TMU-33/E
12. Compressed Gas Cylinder Semitrailer AF/M32A-17
13. Launch Vehicle
14. Pumper Method Liquid Nitrogen Converter Recharging Unit GCU-25/M
15. Trailer-Mounted Launch Vehicle System Checkout Station A/M24A-6
16. Ballistic Missile Erecting-Transporting Boom GSU-193/E, and Rear Trailer Dolly GSU-32/M
17. Skid-Mounted Power Switchboard JEU-1/E
18. Trailer-Mounted Missile Launching Countdown Group A/M24A-3
19. Hydraulic Pumping Unit PMU-30A/E
20. Trailer-Mounted Air Conditioner A/M32C-11
21. Liquid Oxygen Storage Tank TMU-3/E, Liquid Oxygen Valve End Complex, and Liquid Oxygen Pipeline Outfit GSU-199/E
22. Trailer-Mounted Vacuum Pump PMU-1A/M